

CSM—48/24
PART—II/PAPER—VI
MECHANICAL ENGINEERING
PAPER—I

Candidate
must not
write on
this margin.

Time : 3 Hours

Full Marks : 250

*The question paper contains **18 (Eighteen)** questions in **GROUP—A, (12)** and **GROUP—B, (06)** together.*

GROUP—A

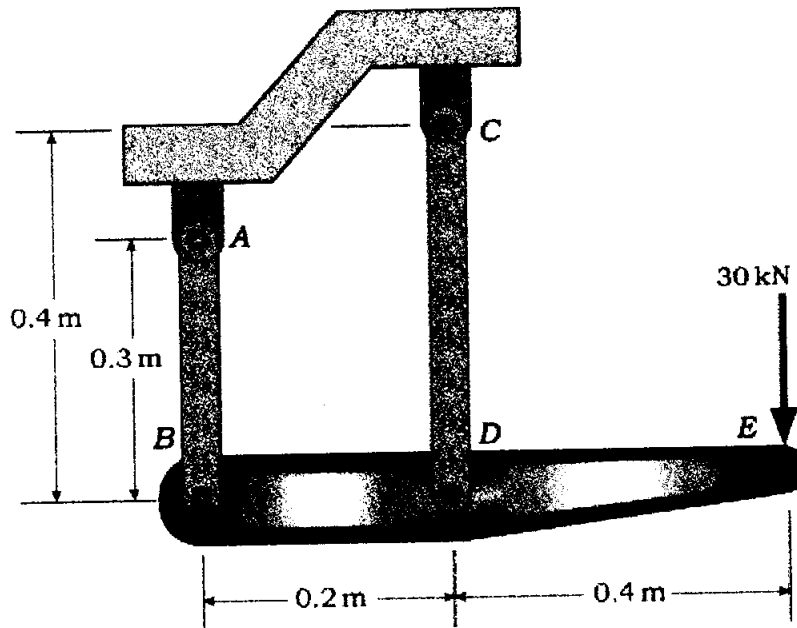
*Candidates to attempt **10 (ten)** questions within word limit of **250**.*

*Each question carries **15** marks.*

1. A gear has 22 teeth cut full depth with pressure angle $\phi = 20^\circ$ and diametral pitch $P = 2$ teeth/in. Find the thickness of the teeth at the base circle and at the addendum circle. Take circular pitch $p = 1.571$ in/tooth, addendum $a = 0.5$ in and dedendum $d = 0.625$ in.
2. A steel shaft of length 1 m and diameter 50 mm is fixed at one end and carries a pulley of mass moment of inertia 25 kg-m^2 at the other end. A band brake exerts a constant frictional torque of 400 N-m around the circumference of the pulley. If the pulley is displaced by 6° and released, then determine—
 - (1) the number of cycles before the pulley comes to rest and;
 - (2) the final settling position of the pulley, $G = 8 \times 10^{10} \text{ N/m}^2$.
3. Explain with a neat diagram the Ackermann steering mechanism.

4. The rigid bar BDE is supported by two links AB and CD . Link AB is made up of aluminum ($E = 70 \text{ GPa}$) and has a cross-sectional area of 500 mm^2 . Link CD is made up of steel ($E = 200 \text{ GPa}$) and has a cross-sectional area of 600 mm^2 . For the 30-kN force shown in the figure below, determine the deflection (a) of B , (b) of D and (c) of E .

**Candidate
must not
write on
this margin.**



5. Explain value analysis procedure in detail.
6. Derive the expressions for the radial pressure and hoop stress at any point for thick cylinder.
7. Derive an expression for distortion energy per unit volume when a body is subjected to principal stress.
8. Explain three types of locators used in jigs and fixtures.
9. Describe the oxyacetylene gas welding. How many types of flames are there in oxyacetylene gas welding and where are they used for welding?

10. Briefly explain the various process parameters that affect the material removal rate and surface quality in ECM.

**Candidate
must not
write on
this margin.**

11. A comparison of monthly sales of an expensive item, against the total number of visits made by salesman during the previous month, yields the following data. Is the correlation of the two variables good enough to enable the number of sales visit, to be adopted as an efficient indicator of future sales?

Sales (x)	1	3	5	7	11
Visits made (y)	2	4	8	9	10

12. Build a C program that creates a macro to calculate the area of a circle using the formula $\text{area} = \pi r^2$ (area = pie $\times$ radius $\times$ radius). In the same program, prompt the user to enter a circle's radius. Use the macro to calculate the circle's area.

GROUP—B

Candidates to attempt 05 (five) questions within word limit of 300.

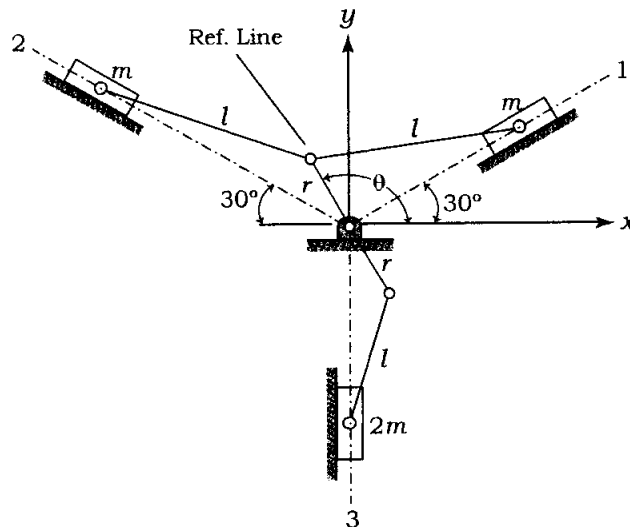
Each question carries 20 marks.

13. A plate cam with a reciprocating radial roller follower is to be designed such that the displacement of the follower is $Y = 15(1 - \cos 2\theta)$ mm. The prime-circle radius is to be $R_0 = 40$ mm, and the roller is to have a radius of $R_r = 12$ mm. The cam is to rotate counter-clockwise. For the cam rotation angle $\theta = 30^\circ$, determine the following :

- (a) The coordinates of the point of contact between the cam and the follower in the rotating coordinate system.
- (b) The radius of curvature of the cam profile.
- (c) The pressure angle of the cam.

14. Determine the magnitudes and orientations of the forces created by the correcting masses needed to balance the first and second harmonic shaking forces of the three-cylinder engine shown in the figure below :

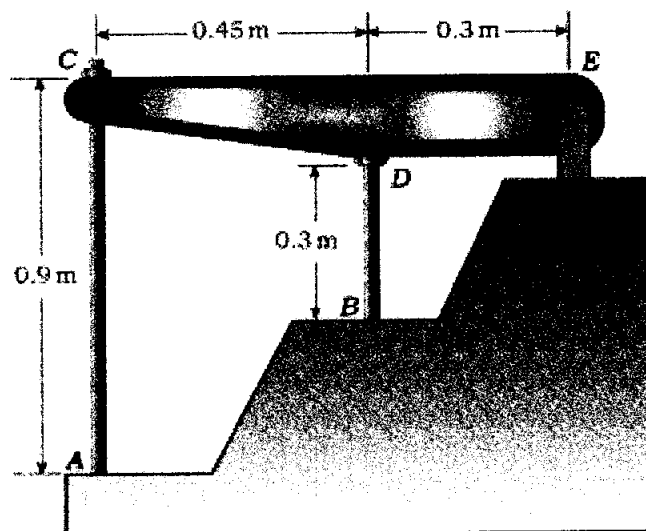
Candidate must not write on this margin.



15. The rigid bar CDE is attached to a pin support at E and rests on the 30 mm diameter brass cylinder BD . A 22 mm diameter steel rod AC passes through a hole in the bar and is secured by a nut which is snugly fitted when the temperature of the entire assembly is 20°C . The temperature of the brass cylinder is then raised to 50°C while the steel rod remains at 20°C . Assuming that no stresses were present before the temperature change, determine the stress in the cylinder in the figure below :

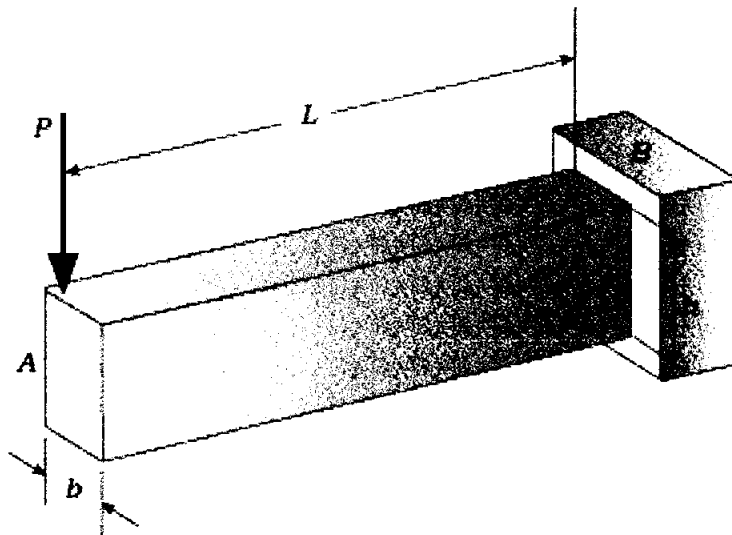
Rod AC : Steel, $E = 200 \text{ GPa}$, $\alpha = 11.7 \times 10^{-6}/^\circ\text{C}$.

Cylinder BD : Brass $E = 105 \text{ GPa}$, $\alpha = 20.9 \times 10^{-6}/^\circ\text{C}$.



16. Determine the strain energy of the rectangular cantilever beam AB shown in the figure below taking into account the effect of both normal and shearing stresses.

**Candidate
must not
write on
this margin.**



17. A small engineering project consists of 6 activities namely A , B , C , D , E and F with duration of 4, 6, 5, 4, 3 and 3 days respectively. Draw the network diagram and calculate EST , LST , EFT , LFT and floats. Mark the critical path and find the total project duration.
18. Describe the following heat treatment procedures for steels and, for each, the intended final microstructure (a) full annealing, (b) normalizing, (c) hardening and (d) tempering.

★ ★ ★

SPACE FOR ROUGH WORK

**Candidate
must not
write on
this margin.**

SPACE FOR ROUGH WORK

**Candidate
must not
write on
this margin.**



SPACE FOR ROUGH WORK

**Candidate
must not
write on
this margin.**

